

Hazard Elimination Project Evaluation

Project Log # 200608072

Hazard Elimination Project W-3427

**Widen SR 2108 (Millbrook Rd) from SR 2030 (Old Wake Forest Rd) to Atlantic Ave to
Convert From a 4-Lane Facility to a 5-Lane Facility with a Two-Way Center Left Turn Lane
Wake County**

Documents Prepared By:

Safety Evaluation Group
Traffic Safety Systems Management Section
Traffic Engineering and Safety Systems Branch
North Carolina Department of Transportation

Principal Investigator



Carrie L. Simpson, PE

Traffic Safety Project Engineer

6/12/2008

Date

Hazard Elimination Project Evaluation Documentation

Subject Location

Evaluation of Hazard Elimination Project W-3427 –
On SR 2108 (Millbrook Rd) from SR 2030 (Old Wake Forest Rd) to Atlantic Ave in Wake County

Project Information and Background from the Project File Folder

The safety countermeasures chosen for the subject location were to widen SR 2108 (Millbrook Rd) to provide a TWLTL (Two-Way Left Turn Lane) from SR 2030 (Old Wake Forest Rd) to Atlantic Ave; relocate one cantilever flasher at the at-grade railroad crossing on SR 2108 (Millbrook Rd) and extend the crossing treatment; and resurface SR 2108 (Millbrook Rd) in this section. The project widened the roadway from a four-lane undivided curb and gutter section to a five-lane curb and gutter section (64' face to face). This section of roadway is approximately 0.23 miles in length. The speed limit on this section of SR 2108 (Millbrook Rd) is 35 mph.

The Project Report in the Project File Folder states that motorists were experiencing delay and Rear End type crashes in trying to access driveways along SR 2108 (Millbrook Rd). The treatable crash patterns were Rear End, Left-Turn, and Sideswipe crashes. It was felt that there would be a reduction in Rear End crashes by constructing a center left turn lane to separate turning traffic from the through traffic. The center left turn lane was also intended to relieve the pressure for left-turning vehicles to make left turns without acceptable gaps, thus reducing Left-Turn Same Roadway crashes. Finally, the center left turn lane was intended to alleviate the pattern of Sideswipe crashes, which were caused by motorists attempting to avoid turning vehicles.

The initial crash analysis for this location was completed from November 1, 1994 through December 31, 1997 with a total of 102 reported crashes. According to the initial crash analysis, there were 51 Rear End crashes, 22 Left-Turn crashes, 9 Sideswipe crashes, and 20 Random crashes. The project was completed on August 25, 2001 at a cost of \$435,000.

Naïve Before and After Analysis

After reviewing the hazard elimination project file folder along with all the crashes at the subject location, the crash data omitted from this analysis to consider for an adequate construction period was from September 1, 2000 through August 31, 2002. The before period consisted of reported crashes from June 1, 1995 through August 31, 2000 (5.25 Years) and the after period consisted of reported crashes from September 1, 2002 through November 30, 2007 (5.25 Years). The ending date for this analysis was determined by the available crash data at the time the crash analysis was completed.

The treatment data consisted of all crashes on 2108 (Millbrook Rd) within a 0' Y-Line from 50' east of SR 2030 (Old Wake Forest Rd) to 50' west of Atlantic Ave. The study limits were cut short at each end in an attempt to remove as many signalized intersection-related crashes as possible. Also, in the before period, a left turn lane existed at each end for the signalized intersections of SR 2030 (Old Wake Forest Rd) and Atlantic Ave. Please see the attached *Aerial Photos* and *Location Map* for further detail.

The following tables depict the Naïve Before and After Analysis for the Total Crashes and Target Crashes at the treatment location. Please note that the Target Crashes for the applied countermeasure include three crash types:

- Target Crash 1. Rear End Crashes (in the Left Thru Lane),
- Target Crash 2. Left-Turn, Same Roadway (LTSR) Crashes, and
- Target Crash 3. Sideswipe Crashes (From the Left).

<u>Table 1a.</u>			
<u>Total Treatment Information</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	129	91	-29.5%
Total Severity Index	3.19	3.13	-1.9%
Target Rear End Crashes	63	22	-65.1%
Target Rear End Severity Index	2.88	2.35	-18.4%
Target LTSR Crashes	4	6	50.0%
Target LTSR Severity Index	2.85	3.47	21.8%
Target Sideswipe Crashes	8	5	-37.5%
Target Sideswipe Severity Index	1.92	1.00	-47.9%
Volume	24,000	20,000	-16.7%

<u>Table 1b.</u>			
<u>Total Crash Information</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Fatal Injury Crashes	0	0	N/A
Non-Fatal Injury Crashes	29	17	-41.4%
Total Injury Crashes	29	17	-41.4%
Night Crashes	13	14	7.7%
Wet Crashes	33	22	-33.3%

The naïve before and after analysis for the treatment location resulted in a 30 percent decrease in Total Crashes, a 65 percent decrease in Target Rear End Crashes, a 50 percent increase in Target LTSR Crashes, a 38 percent decrease in Target Sideswipe Crashes, and a 17 percent decrease in Average Daily Traffic (ADT). The before period ADT year was 1998 and the after period ADT year was 2005.

Results and Discussion

The naïve before and after analysis involving the comparison of treatment actual before data versus treatment actual after data resulted in a 30 percent decrease in Total Crashes, a 65 percent decrease in Target Rear End Crashes, a 50 percent increase in Target Left-Turn, Same Roadway (LTSR) Crashes, and a 38 percent decrease in Target Sideswipe Crashes. The summary results above demonstrate that the Treatment Location appears to have had an decrease in the number of Total and Target Crashes (with the exception of Target LTSR Crashes) from the before to the after period using naïve methodologies.

The Total Severity Index decreased minimally (by 2 percent) from the before to the after period. The number of Total Injury Crashes, however, decreased more substantially (by 41 percent) from 29 crashes in the before period to 17 in the after period.

The TWLTL (Two-Way Left Turn Lane) allows simultaneous left turns from the center lane. Vehicles from either direction of traffic flow enter the center lane to make left turns, thus removing themselves from the through lanes. In general, this may increase the capacity of the through lanes, reduce vehicular conflicts, and enable traffic to move more efficiently.¹

The Target Crashes for this countermeasure in a five lane section include Rear End Crashes (in the Left Thru Lane), LTSR Crashes, and Sideswipe Crashes (From the Left). Rear End Crashes (in the Left Thru Lane) are considered treatable by the countermeasure because a TWLTL separates turning traffic from the thru traffic. LTSR Crashes are considered treatable by the countermeasure because a TWLTL relieves the pressure for left-turning vehicles to make left turns without acceptable gaps. Finally, Sideswipe Crashes (From the Left) are considered treatable by the countermeasure because a TWLTL will reduce avoidance crashes caused by motorists attempting to avoid turning vehicles.

Target Rear End Crashes were the predominant crash type in the before period. In the before period, there were 63 Target Rear End Crashes at the treatment location, accounting for 49 percent of all crashes. A majority of the Target Rear End Crashes (45 of the 63) involved eastbound traveling vehicles concentrated near Lacy Ave and Atlantic Ave (most likely related to the signalized intersection at Atlantic Ave). In the after period, there were 22 Target Rear End crashes at the treatment location, accounting for 24 percent of all crashes. After period Target Rear End crashes were concentrated in the eastbound direction near Atlantic Ave.

The TWLTL appears to have had a minimal effect on the number of Target LTSR Crashes and Target Sideswipe Crashes. Target LTSR Crashes increased by 50 percent, from 4 crashes in the before period to 6 crashes in the after period. After period Target LTSR crashes were concentrated at the intersection with Lacy Ave. Target Sideswipe Crashes decreased by 38 percent, from 8 crashes in the before period to 5 crashes in the after period.

There was a pattern of Left-Turn Crashes near the Kroger Shopping Center in both the before and after period, which appears to be related to the access control. Please see the *Before and After Collision Diagrams*. Vehicles are attempting to cross multiple lanes of traffic to turn left out of the Kroger Shopping Center entrance. In the before period, there were 11 crashes involving vehicles turning left out of the Kroger Shopping Center and being struck by eastbound vehicles in the left

lane. In the after period, the pattern shifted to the TWLTL, and there were 14 crashes involving vehicles turning left out of the Kroger Shopping Center and being struck by eastbound vehicles in the TWLTL. Numerous crash reports mentioned “courtesy gaps” as contributing to these crashes. The Kroger Store in this shopping center has been closed for several years, yet the crash pattern has increased in the After Period. These Frontal Impact crash types may be mitigated by use of a median treatment that would not allow traffic to turn left into or out of the shopping center driveway.

The number of Total Wet Crashes decreased (by 33 percent) from 33 crashes in the before period to 22 in the after period. The pavement resurfacing may have contributed to this crash decrease, by providing the roadway with better drainage and pavement friction.

The calculated benefit to cost ratio for this project is 1.36 considering total crashes. The benefit to cost ratio considering only target crashes is 1.41. The benefits are calculated using the change in annual crash costs from the before to the after period. Operational and other benefits related to the project are not considered in this analysis. The costs of the project include the actual construction costs as well as the increase in annual maintenance costs.

Please see the attached *Treatment Site Photos*. The photos were taken while driving east on SR 2108 (Millbrook Rd) and depict the current TWLTL. As the Safety Evaluation Group completes additional reviews for this type of countermeasure, we will be able to provide more objective and definite information regarding actual crash reduction factors.

Reference:

1. “Two-Way Left-Turn Lane” By John McCree
Illinois Municipal Review / July 1987

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: SR 2108 from SR 2030 to Atlantic Ave
COUNTY: Wake
FILE NO.: W-3427

BY: CLS
DATE: 6/17/2008
NOTES: Total Crashes

DETAILED COST: TYPE IMPROVEMENT - Center Turn Lane

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$435,000	20	0.102	\$44,306
	\$0	0	0.000	\$0
Right-of-Way	\$0	0	0.000	\$0

TOTALS	\$435,000	20	0.102	\$44,306
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ESTIMATED INCREASE IN ANNUAL MAINT. COST =	\$690
ESTIMATED INCREASE IN ANNUAL UTILITY COST =	\$0
TOTAL ANNUAL COST=	\$44,996
TOTAL COST OF PROJECT=	\$435,000

COMPREHENSIVE COST REDUCTION:

ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES

TIME PERIOD	YEARS	K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	ANNUAL COSTS
BEFORE	5.25	1	0.19	28	5.33	100	19.05	\$265,524
AFTER	5.25	1	0.19	16	3.05	73	13.90	\$204,324

Annual Benefits from Crash Cost Savings \$61,200

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$16,204

BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 1.36

TOTAL COST OF PROJECT - \$435,000 COMPREHENSIVE B/C RATIO - 1.36

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: SR 2108 from SR 2030 to Atlantic Ave
COUNTY: Wake
FILE NO.: W-3427

BY: CLS
DATE: 6/17/2008
NOTES: Target Crashes

DETAILED COST: TYPE IMPROVEMENT - Center Turn Lane

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
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	\$0	0	0.000	\$0
Right-of-Way	\$0	0	0.000	\$0
TOTALS	\$435,000	20	0.102	\$44,306

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COMPREHENSIVE COST REDUCTION:

ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES

TIME PERIOD	YEARS	K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	ANNUAL COSTS
BEFORE	5.25	0	0.00	18	3.43	57	10.86	\$104,057
AFTER	5.25	0	0.00	6	1.14	27	5.14	\$40,629

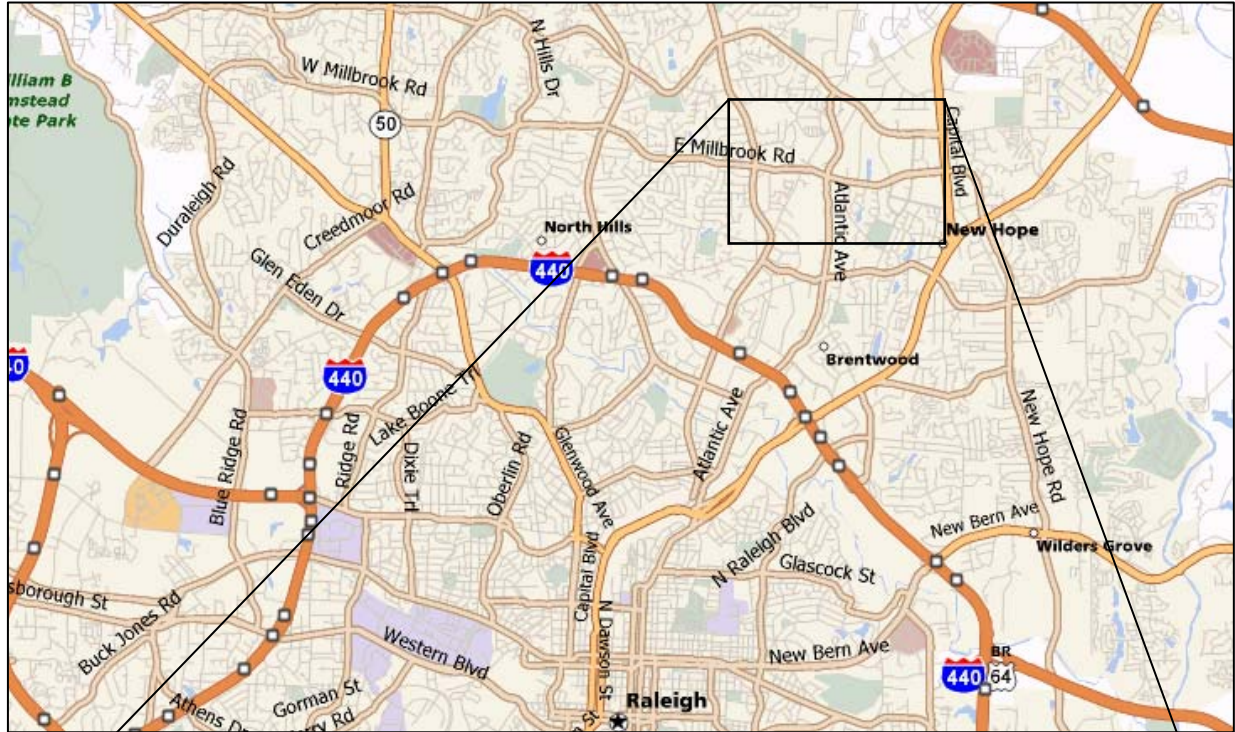
Annual Benefits from Crash Cost Savings \$63,429

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$18,433

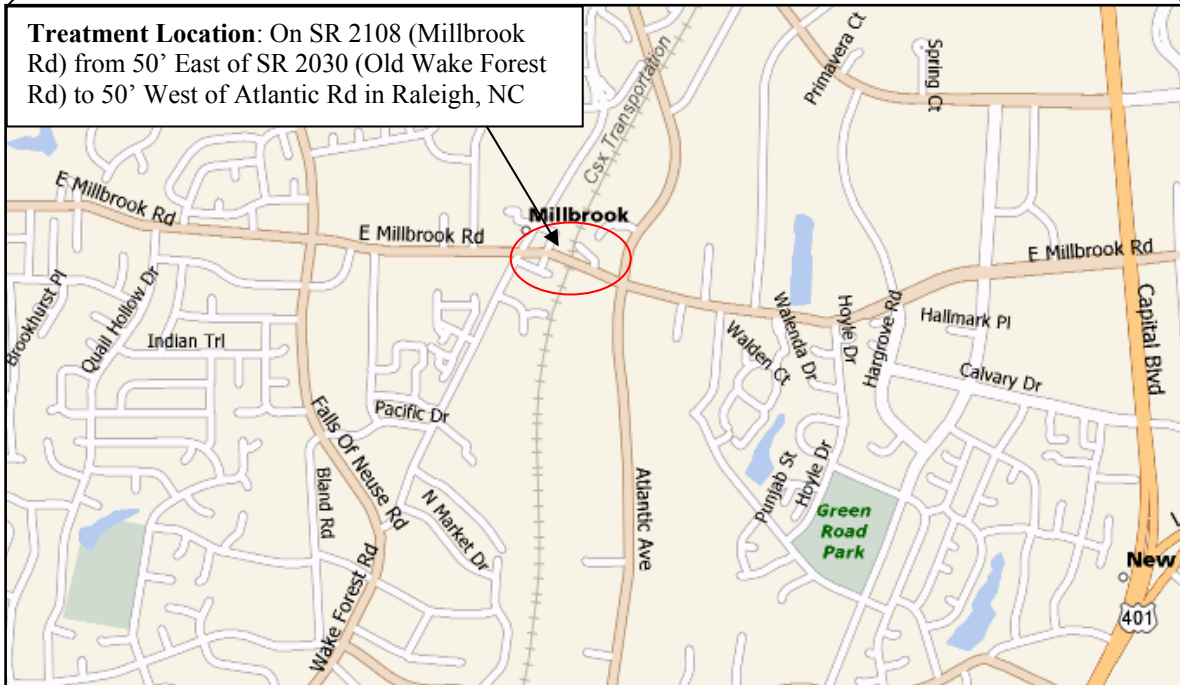
BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 1.41

TOTAL COST OF PROJECT - \$435,000 COMPREHENSIVE B/C RATIO - 1.41

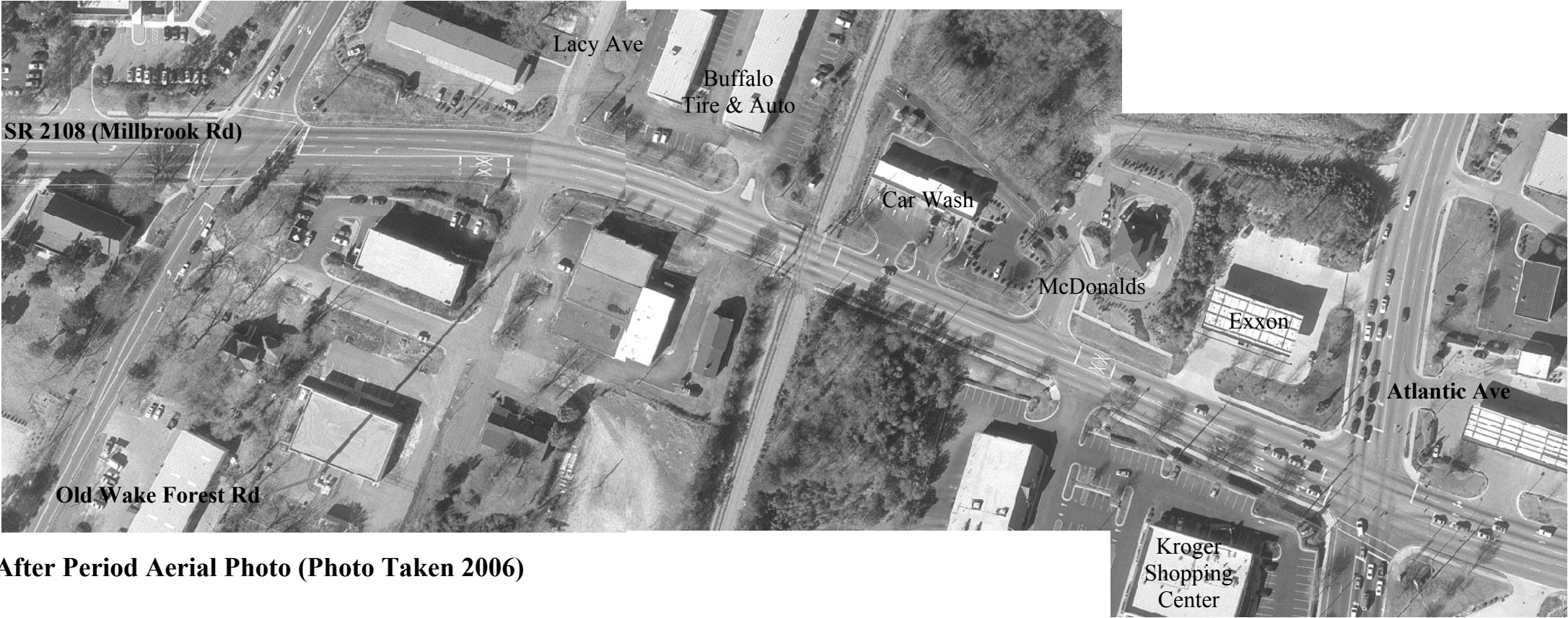
W-3427 Location Map



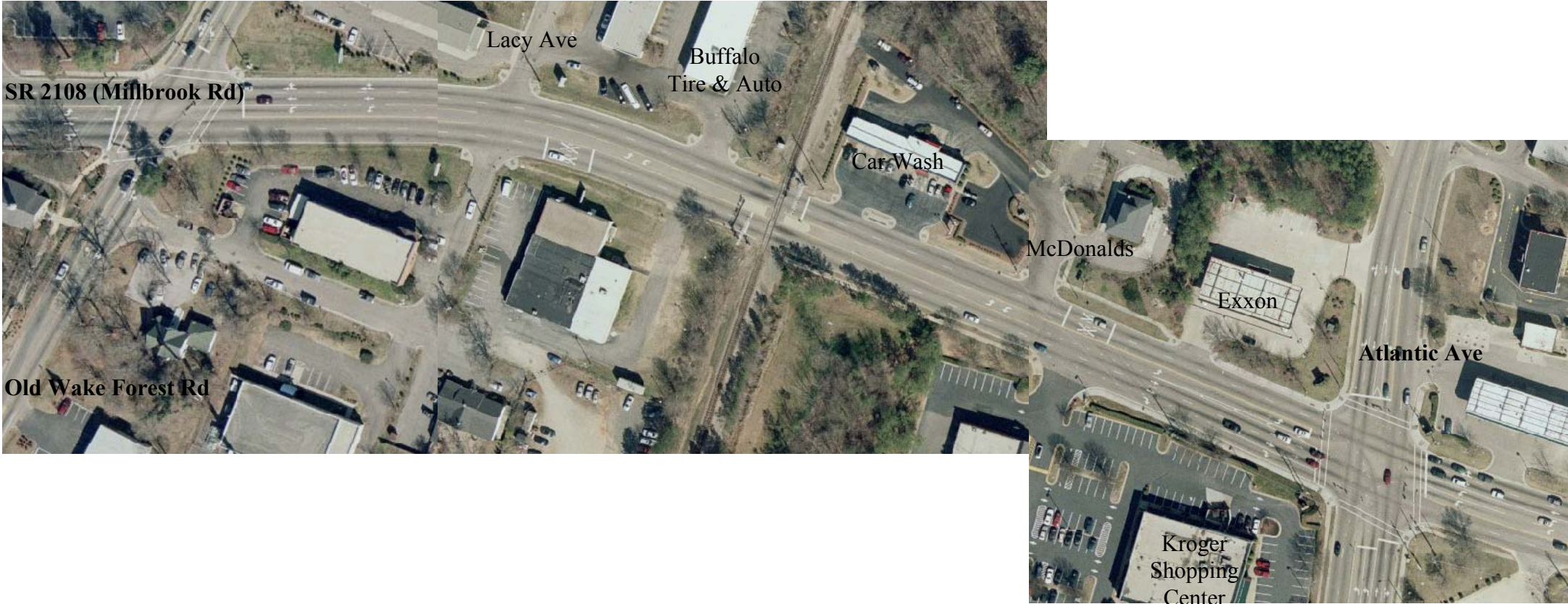
Treatment Location: On SR 2108 (Millbrook Rd) from 50' East of SR 2030 (Old Wake Forest Rd) to 50' West of Atlantic Rd in Raleigh, NC



Before Period Aerial Photo (Photo Taken 1999)



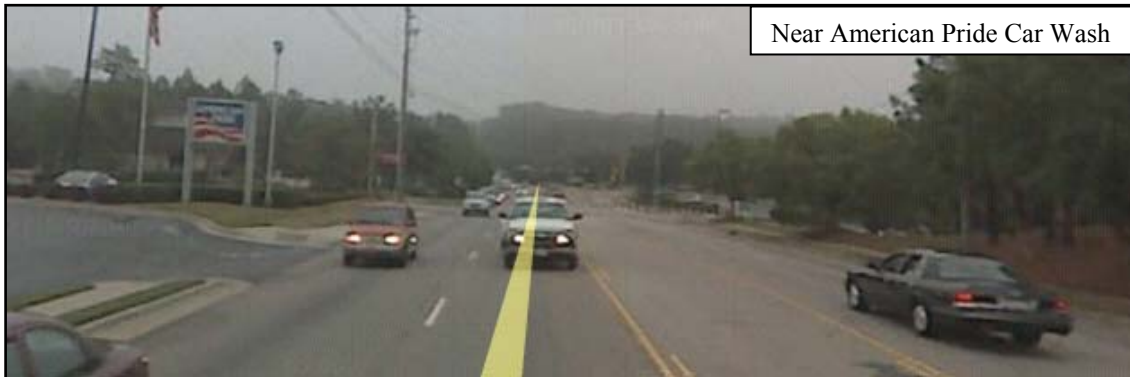
After Period Aerial Photo (Photo Taken 2006)



Treatment Location Photos – Driving Eastbound on SR 2108 (Millbrook Rd)



Treatment Location Photos – Driving Eastbound on SR 2108 (Millbrook Rd)



Treatment Location Photos – Driving Eastbound on SR 2108 (Millbrook Rd)



SR 2108 (Millbrook Rd) from 50' East of
SR 2030 (Old Wake Forest Rd) to 50' West of Atlantic Ave
Wake County
June 1, 1995 - August 31, 2000
(5.25 YRS)
Before Period - Total Crashes



LEGEND

→

MOVING VEHICLE

- - - →

PEDESTRIAN

⊠

PARKED VEHICLE

⊠ ↗

PARKING VEHICLE

□

FIXED OBJECT

→
→

HEAD ON

→
←

REAR END

→
↘

RAN OFF ROAD

↘

ANGLE

↘
↘

TURNING

→
←

BACKING

→
↗

SIDESWIPE

→
○ ○

OUT OF CONTROL

→
○ ○

INJURY

→
● ●

FATALITY

→

9 MPH OR LESS

→

10 MPH TO 19

→

20 MPH TO 29

→

30 MPH TO 39

→

40 MPH TO 49

→

50 MPH TO 59

→

60 MPH TO 69

→

70 AND UP

→

SPEED UNKNOWN

→

DAYLIGHT CRASH

→

DARK CRASH

P

PEDESTRIAN

B

BICYCLE

T

TRAIN

A

ANIMAL

🔥

VEHICLE FIRE

⬮

DRIVER AT FAULT

D

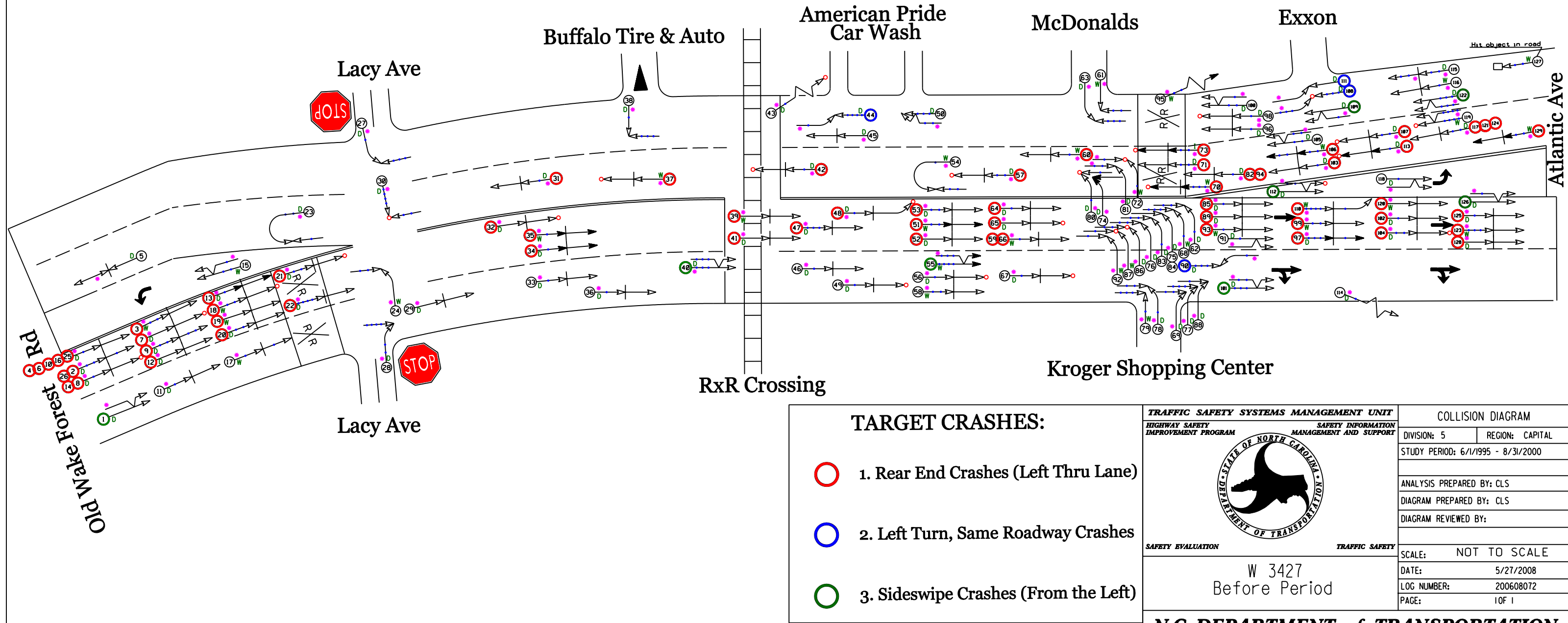
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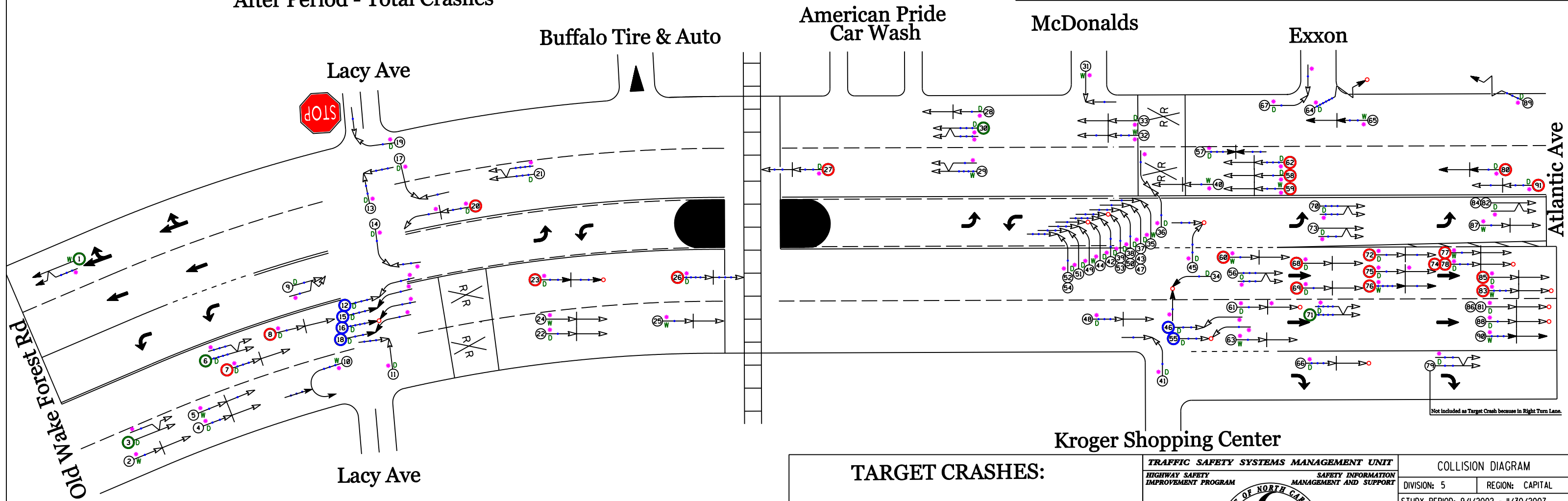
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ICY OR SNOWY



SR 2108 (Millbrook Rd) from 50' East of
SR 2030 (Old Wake Forest Rd) to 50' West of Atlantic Ave
Wake County
September 1, 2002 - November 30, 2007
(5.25 YRS)

After Period - Total Crashes



TARGET CRASHES:

- 1. Rear End Crashes (Left Thru Lane)
- 2. Left Turn, Same Roadway Crashes
- 3. Sideswipe Crashes (From the Left)

TRAFFIC SAFETY SYSTEMS MANAGEMENT UNIT		COLLISION DIAGRAM	
HIGHWAY SAFETY IMPROVEMENT PROGRAM	SAFETY INFORMATION MANAGEMENT AND SUPPORT	DIVISION: 5	REGION: CAPITAL
		STUDY PERIOD: 9/1/2002 - 11/30/2007	
SAFETY EVALUATION	TRAFFIC SAFETY	ANALYSIS PREPARED BY: CLS	
		DIAGRAM PREPARED BY: CLS	
W 3427 After Period		DIAGRAM REVIEWED BY:	
		SCALE: NOT TO SCALE	
		DATE: 5/27/2008	
		LOG NUMBER: 200608072	
		PAGE: 1 OF 1	

N.C. DEPARTMENT of TRANSPORTATION
DIVISION of HIGHWAYS
TRAFFIC ENGINEERING AND SAFETY
SYSTEMS BRANCH